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Field Portable GC-MS Instrument for Analysis of Organic Compounds in Dredged Material

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Background

- July 23, 2008, Oil barge carrying Fuel Oil No. 6 sinks near mile 96 above Head of Passes
- Fuel Oil No. 6 is heavy, dense oil, mixed with diesel, often contains lead and vanadium
- ERDC researchers respond via DOTS to MVN requests for support
  - Low Level Laboratory analyses
    - Oil and Grease
    - GRO, DRO, ORO
    - PAHs
    - Metals
  - Field Portable GC-MS
    - ICx Griffin 400 GC-Iontrap-MS
    - PAHs, indication of DRO
- In situ development of a colorimetric field screening test kit
  - Solvent extraction of water/sediment used to indicate presence of heavy oil

Instrumentation

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- **ICx Griffin 400/450 Field Portable GC-MS**
  - **Originally developed and currently used for explosives analysis in groundwater**
  - **GC-MS laboratory based instruments are routinely used for PAH and GRO/DRO/ORO analyses**
- **Portable/Transportable**
  - **2’ cube**
  - **75 pounds**
  - **2 kW generator**
  - **Scotty He bottle**

Instrumentation

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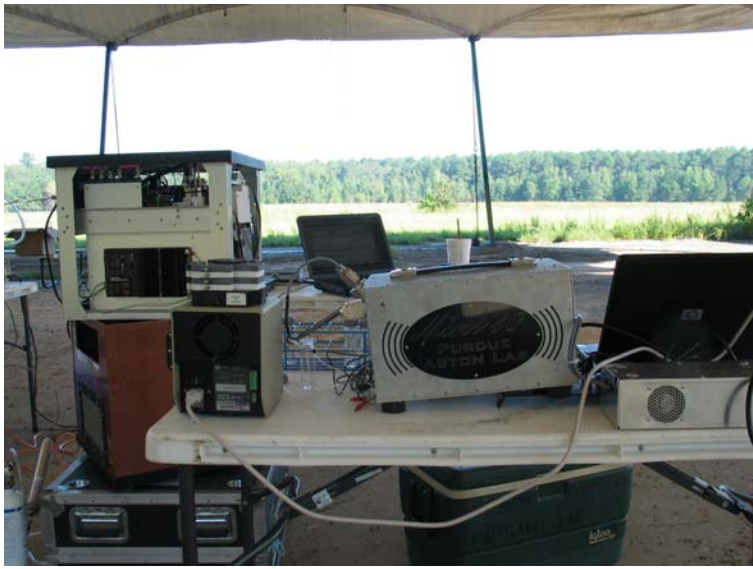
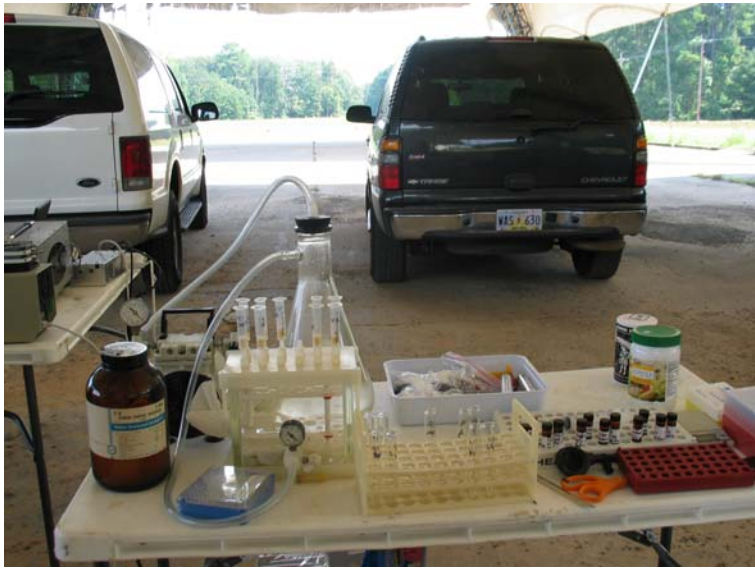
ICx Griffin 400 and Mini-10 MS at LAAP for field analysis of explosives



Field extraction apparatus for explosives in groundwater



Preparation for Deployment to Dredge

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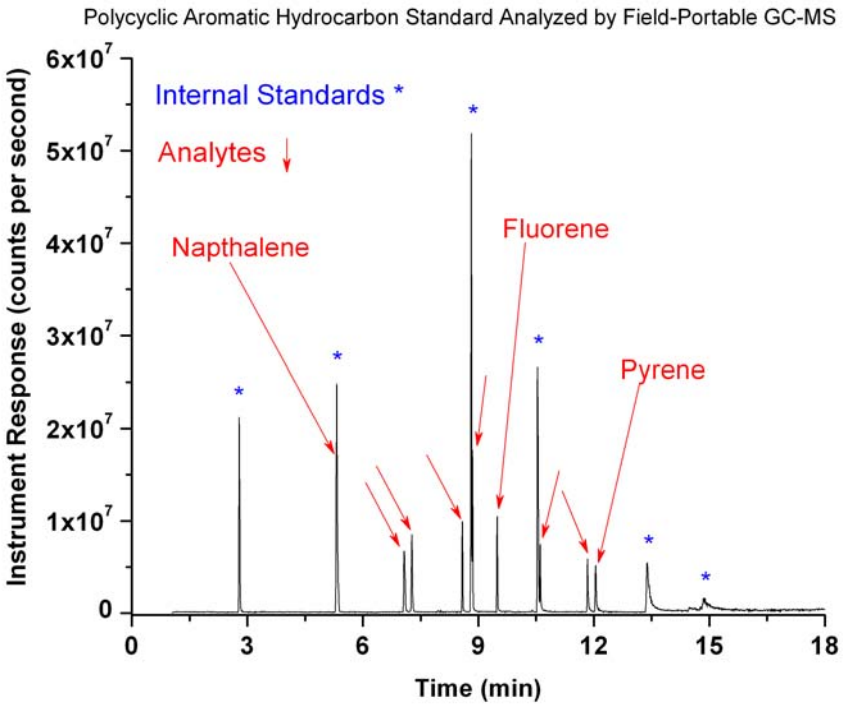
- **Instrumentation was optimized and calibrated for PAHs**
  - **Initial tests on DRO**
  - **Ready for deployment within 3 days of notification by MVN**
- **Extraction techniques for sediments and waters will determine reporting limits**
  - **Sonication**
  - **Separatory Funnel**

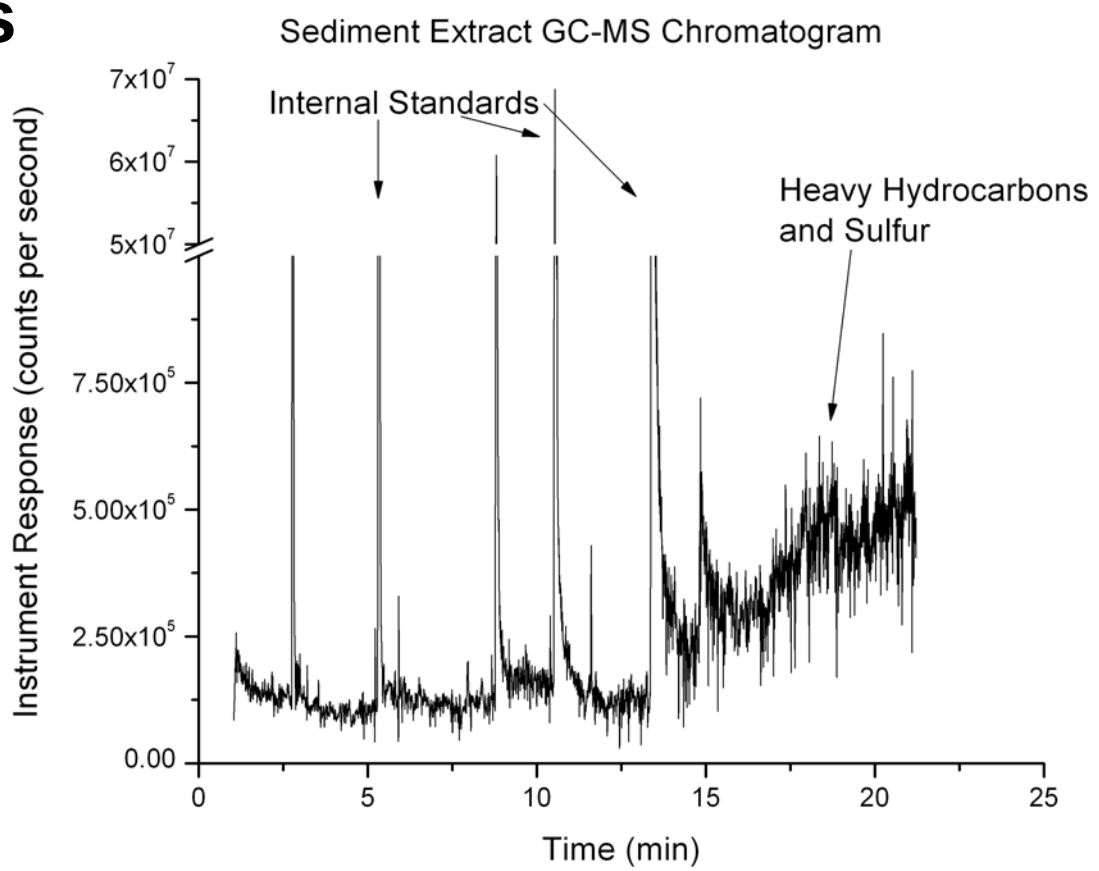
In-field Analysis

- **Modified Method 8270**
  - **SIM and Full Scan mode**
  - **Low standard 0.1 mg/L**
- **2 g of sediment extracted with 12 mL solvent, sonicated for 15 min**
- **100 mL of water extracted by separatory funnel with 20 mL of solvent**



In-field Chromatogram

- **Very low level contamination found, interferences from sulfur and heavy hydrocarbons**



Results Comparison

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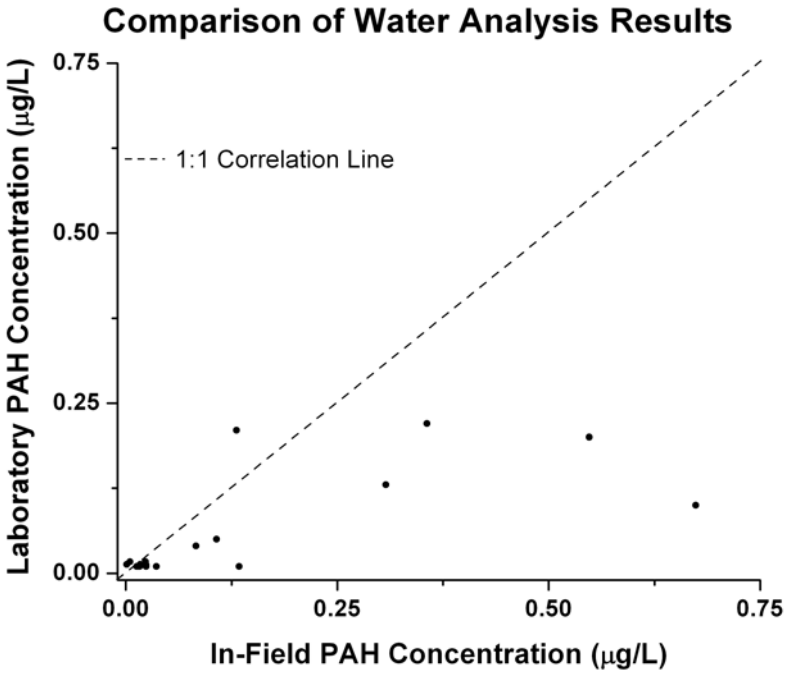
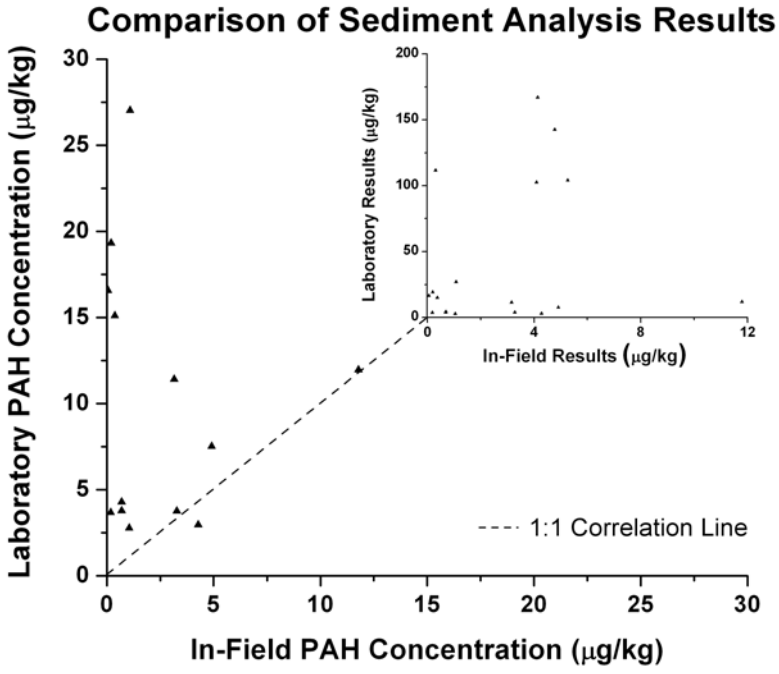
All results were below field instrumentation detection limits (20 µg/L and 600 µg/kg)





Most results were below laboratory instrumentation detection limits, including GC-MS SIM with extract evaporative concentration (0.05 µg/L and 0.02 mg/kg)

Net Results – View from ERDC and MVN

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•Even though results are below field detection limits, and near laboratory detection limits, sound decisions can be made, in near real time, based on definitive chemical analyses.

•Initial decisions on the level of oil contamination were based solely on visual inspection of the hopper, and were highly dependent on the inspectors experience with oil spills. Inspectors were reluctant to allow dredge to operate if ANY sheening was observed on the surface of the hopper bin, resulting in frequent shut-downs often exceeding 12 hours.

•Collection of sediment and surface sheens for on-board analysis allowed for direct comparison between visual inspections and oil concentration in dredged material.

•Near real-time results allowed MVN to make confident and informed decisions during dredging operations that were both protective of environmental resources and beneficial to dredging productivity.

•On-board results were a critical first step for the MVM to resume control of dredging operations from an emotionally charged multi-agency response team.

Rapid Field Screening Needed

- Field portable GC-MS provides high quality analytical data but requires experienced operators (Dredge deployment of 3 PhD's)
  - Large capital investment ($105K)
- Quick screening procedures needed
  - Multiple simultaneous deployments, relatively inexpensive, fast
- Drawback – not equivalent results, i.e. screening 'yes/no' versus quantitative concentrations

Field Screening Method

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ERDC Field Fuel Oil Screening Kit

Test vials containing hexane extraction solvent and drying agent, and example extract solution

Scoop and Spatula for measuring and mixing

Blank to 100 mg/L

Calibration Solutions

Field Screening Method

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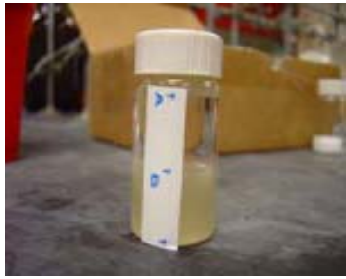
Dredged Material Collection and Screening Procedure

Sediment

Water



Conclusions

- **Field portable GC-MS instrumentation demonstrated for near real time analysis of organics in dredged material**
  - **Modification of Standard EPA Method 8270**
  - **Standard, approved method, for determination of organic compounds**
- **Field Screening Kit developed for fast ‘yes/no’ detection of heavy oils**
  - **Semi-quantitative (Kit contains standards)**
  - **Provides dredging contractor with a simple kit to gauge level of oil contamination if sheens were present in hopper bin.**
  - **Reduces need for MVN or Coast Guard personnel to inspect hopper bins, or be present 24 hours a day to inspect each hopper load.**